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AN ION SOURCE WHICH GENERATES IONS THROUGH IMPACT IONIZATION OF GAS MOLECULES

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Ion sources which generate ions by means of impact ionization of gas molecules and which contain an electron gun, an accelerating diaphragm, and ion and electron collectors are well known.

In the proposed ion source, in contrast to known ones, there is no magnetic field, and the ion collector, which is at negative potential, is located behind the electron collector, which also acts as an electrode to draw off the ions and has a central aperture.

Such a design of the ion source permits an intense ion beam (i.e., high gas current) focused by an electron beam pointed in the same direction to be obtained in a high vacuum, while still permitting the necessary separation of ion and electron beams to be carried out.

A diagram of the proposed ion source is shown in the drawing.

The electrons are generated by electron gun 1 and then accelerated by a constant electric field created by accelerating diaphragm 2. Next the electrons come into the space between accelerating diagram 2 and specially shaped electrode—electron collector 3, which has central aperture 4. The potential of collector 3 is below that of accelerating

diaphragm 2, thus creating a constant electric field between them, which decelerates the electrons.

At certain values of the decelerating electric field (i.e., potential gradients) in the space between diaphragm 2 and collector 3 (as a result of impact ionization of gas molecules) a quantity of positive ions sufficient to neutralize the negative charge of the electron beam is created and accumulated.

Since the electrons move in a direction towards the collector with decreasing velocities, the ionization over a unit path of the electron beam in the space between diaphragm 2 and collector 3 will be different; it will increase (within certain limits) as the potential decreases, i.e., the concentration of the positive ions in the volume of the electron beam increases as we approach electron collector 3 (this happens because the potentials of diaphragm 2 and collector 3 are chosen in such a way that the potential of maximum specific ionization lies between them, being considerably nearer the potential of collector 3).

As a result of the neutralization of the volume charge in the beam the motion of the ions thus created occurs in the direction of motion of the electrons, i.e., toward electron collector 3, and then on through central aperture 4 in collector 3 to ion collector 5, which is at negative potential. When this happens, the necessary separation of the ion and electron beams occurs, an acceleration of the positive ions takes place in the space between collectors 3 and 5, and an ion current is created.

The nonuniform distribution of the positive ions along the beam leads to a longitudinal compression of the ions in the beam. Moreover, since there exists in each cross section of the beam a potential

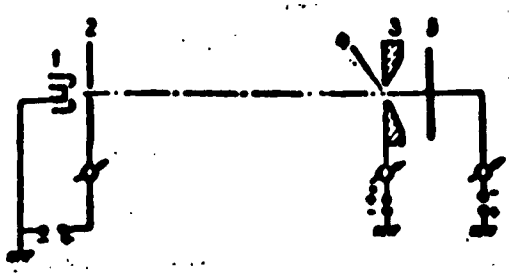
minimum created by the electrons, the positive ions will also move toward the axis of the beam and be trapped in ion volume.

Thus there occurs an accumulation of positive ions in the volume of the electron beam, a neutralization of the volume charge, and ionic focusing of the electron beam, as a result of which the beam assumes a nearly cylindrical shape. All this leads to a rise in the ionic concentration in the volume of the focused beam, an increase in the density of the ions in the beam, and consequently to an increase in the ion current. The ion current will be all the greater, the better the beam is focused for a given electron current.

It is also possible to create an ion current in the shape of a conically convergent beam. This is achieved by special design of electron and ion collectors 3 and 5, the surfaces and shape of which are chosen on the basis of the laws of electron optics.

Object of Invention

An ion source generating ions by impact ionization of gas molecules and based on ionic focusing of the electron beam under a high vacuum, containing an electron gun, an accelerating diaphragm, and electron and ion collectors, differing in that for the purpose of obtaining under a high vaccum without a magnetic field an intense ion current, which is focused by an electron beam pointed in the same direction, and for the purpose of effecting the necessary separation of ion and electron beams, the ion collector, which is at negative potential, is located behind the electron collector, which also acts as an electrode to draw off the ions and has a central aperture.



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